OPTICAL SCANNING APPARATUS

BACKGROUND OF THE INVENTION

Field of the Invention

5   The present invention relates to an optical scanning apparatus in which a photosensitive member is scanned with a plurality of laser beams modulated according to an image signal to form a latent image. In particular, the present invention relates to an

10   optical scanning apparatus for controlling a sub scanning pitch of a plurality of semiconductor lasers, and an image forming apparatus using the optical scanning apparatus.

Related Background Art

15   In an optical scanning apparatus in which a laser beam emitted by a laser beam driving circuit of a semiconductor laser is modulated according to an image signal and a photosensitive drum is scanned with the laser beam by a scanner motor for raster

20   scanning to form a latent image, it is necessary to provide a plurality of single beam semiconductor lasers or a plurality of multi-beam semiconductor lasers. In addition, in the case of a system composed of the multi-beam semiconductor lasers, it

25   is necessary to detect scanning positions of the respective laser beams such that a pitch in the sub scanning direction becomes predetermined spaces.

On the other hand, there is a method in which a plurality of light receiving sensors are arranged on an axis substantially perpendicular to the scanning direction at predetermined spaces, and it is judged

5   that the spaces between the laser beams become the predetermined spaces through the fact that each of a plurality of laser beams passes through a corresponding light receiving sensor (for example, JP 2000-180745 A, JP 10-090615 A, and JP 10-090616 A).

10   However, in the above-mentioned conventional example, high precision mounting is required for positioning the plurality of light receiving sensors. In particular, variations in the direction substantially perpendicular to the scanning direction

15   may cause the cases where laser beams cannot be detected. In addition, time lengths or voltage values of signals outputted from the light receiving sensors are measured and scanning positions are calculated from differential values thereof.

20   Accordingly, it is difficult to detect slight changes in the scanning positions between the plurality of laser beams.

SUMMARY OF THE INVENTION

25 .   A primary object of the present invention is to provide an optical scanning apparatus in which resolution in a sub scanning direction of a plurality

of lasers can easily be adjusted with a simple
algorithm.

In order to achieve the above-mentioned object,
according to a first aspect of the present invention,
5   there is provided an optical scanning apparatus which
has a scanning position detecting section in which a
plurality of light receiving sensors are arranged at
predetermined spaces in a direction substantially
perpendicular to the scanning direction without being
10   overlapped with the scanning direction, and each of
the light receiving sensors has a shape in which one
side into which scanning light of a laser beam is
entered is substantially perpendicular to the
scanning direction, an opposite side is slanted with
15   respect to the scanning light, and at least one of
recess is provided to the slanted side, and it is
detected that pulse widths of respective output
signals obtained by scanning a scanning position
detecting sensor composed of the plurality of light
20   receiving sensors with the scanning light of the
plurality of laser beams are smaller than a
predetermined pulse width, whereby resolution in a
sub scanning direction of the plurality of lasers can
easily be adjusted with a simple algorithm.

25   The above and other objects, features, and
advantages of the invention will become more apparent
from the following detailed description taken in

conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a structure of an optical scanning apparatus according to the present invention;

Fig. 2 is a structural view showing a structure of a scanning position detecting sensor according to a first embodiment;

Fig. 3 is a structural view showing a structure of a scanning position detecting sensor according to a second embodiment;

Fig. 4 is a structural view showing a structure of a scanning position detecting sensor according to a third embodiment;

Fig. 5 is a structural view showing a structure of a scanning position detecting sensor according to a fourth embodiment;

Figs. 6A and 6B are structural views showing structures of scanning position detecting sensors according to a fifth embodiment;

Figs. 7A, 7B and 7C are structural views showing structures of scanning position detecting sensors according to a sixth embodiment;

Fig. 8 is a structural view showing a structure of a scanning position detecting sensor according to a seventh embodiment;

Fig. 9 is a structural view showing a structure

of a scanning position detecting sensor according to a eighth embodiment;

Fig. 10 is a block diagram showing a structure of a scanning position detecting circuit of the present invention;

Fig. 11 is a timing chart showing output states of main blocks;

Fig. 12 is a block diagram showing another structure of a scanning position detecting circuit of the present invention;

Figs. 13A and 13B show waveforms in main blocks of the scanning position detecting circuit of the present invention; and

Fig. 14 is a flow chart in the scanning position detecting circuit of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described in detail below with reference to the accompanying drawings showing a preferred embodiment thereof. In the drawings, elements and parts which are identical throughout the views are designated by identical reference numeral, and duplicate description thereof is omitted.

Fig. 1 is a partial block diagram showing a structure of an optical scanning apparatus according to the present invention. An optical scanning unit 1

includes a semiconductor laser 3 and a semiconductor laser 5. A laser synthesizing unit 2 is composed of the semiconductor laser 3, the semiconductor laser 5, a collimator lens 7, a collimator lens 8, a prism 9,

5 and a unit rotation driving section (not shown). A rotational axis "A" of the rotation driving section is in parallel to the optical axis of the semiconductor laser 3 and the optical axis the semiconductor laser 5 and located in a central region.

10 In a non-image region, a laser beam 4 emitted from the semiconductor laser 3 is entered into a cylindrical lens 10 through the collimator lens 7 and the prism 9 and reaches a polygon mirror 11. The polygon mirror 11 is rotated at a constant angular

15 rate by a scanner motor which is not shown. The laser beam 4 which has reached the polygon mirror 11 is deflected by the polygon mirror 11. The deflected laser beam is converted by an f-θ lens 12 such that it becomes uniform scanning in a direction

20 perpendicular to the rotational direction of a photosensitive drum 17, the beam is reflected on a reflecting mirror 13, and is received in a scanning position detecting sensor 14. In an image region, after a laser beam 15 passes through the f-θ lens 12

25 as in the case of the laser beam 4, a photosensitive drum 17 is irradiated with the laser beam 15 through a reflecting mirror 16.

On the other hand, a laser beam 6 emitted from
the semiconductor laser 5 is entered into the prism 9
through the collimator lens 8. The laser beam 6
deflected by the prism 9 is synthesized with the
5   laser beam 4 at preset beam spaces. In the non-image
region, the laser beam 6 is entered into the
cylindrical lens 10 and is deflected by the polygon
mirror 11. The deflected laser beam 6 is entered
into the f-θ lens 12 and is received in the scanning
10   position detecting sensor 14 by the reflecting mirror
13. In the image region, the laser beam 6 travels as
in the case of the semiconductor laser 3. Therefore,
the description is omitted here.

An output of the scanning position detecting
15   sensor 14 is sent to a beam pitch control section 18.
The beam pitch control section 18 includes a scanning
position detecting circuit 19 and a laser rotation
driving circuit 20. The laser rotation driving
circuit 20 controls the unit rotation driving section
20   (not shown) based on an output of the scanning
position detecting circuit 19.

(First Embodiment)

Fig. 2 is a structural view showing a structure
of a scanning position detecting sensor according to
25   the present invention. Hereinafter, the case where
the scanning position detecting sensor 14 is scanned
with two laser beams will be described as an example.

The scanning position detecting sensor 14 is composed
of two photo sensors having the same shape, that is,
a photo sensor 21 and a photo sensor 22. In order
not to overlap with a scanning direction X of two
laser beams (LD1 and LD2), the photo sensor 21 and
the photo sensor 22 are arranged at a space d in a
direction substantially perpendicular to the scanning
direction X. Here, the photo sensor 21 and the photo
sensor 22 are of a congruent shape, that is, a shape
in which both photo sensors completely coincide with
each other when they are overlapped with each other.
Therefore, a scanning position detecting section
including the plurality of light receiving sensors is
provided. Here, the light receiving sensors have the
same shape, the same size, and the same orientation.
The number of the light receiving sensors is equal to
or larger than the number of beams. The light
receiving sensors are arranged at predetermined
spaces in the direction substantially perpendicular
to the scanning direction X without being overlapped
in the scanning direction X. A shape of the
respective light receiving sensors is made to a
polygon axisymmetric with respect to an axis parallel
to the scanning direction X or an axis substantially
perpendicular to the scanning direction X. This is
also to provide the following scanning position
detecting section. That is, the plurality of light

receiving sensors are arranged at the predetermined
spaces in the sub scanning direction without being
overlapped with each other. With respect to the
shape of the respective light receiving sensors, the
5   edges thereof in a main scanning direction start side
are in parallel to each other, the edges thereof in a
main scanning direction end side are in parallel to
each other, and the edge in the main scanning
direction start side and the edge in the main
10   scanning direction end side are not parallel to each
other.

Here, assume that a space d between the photo
sensor 21 and the photo sensor 22 is equivalent to
600 dpi (42.23 μm). The photo sensor 21 is selected
15   so as to receive only a light output from a spot 23
irradiated with the laser beam 1 (LD1) and the photo
sensor 22 is selected so as to receive only a light
output from a spot 24 irradiated with the laser beam
2 (LD2). In the case where a scanning space between
20   a scanning line 25 of the laser beam LD1 and a
scanning line 26 of the laser beam LD2 is d, when the
scanning position detecting sensor is constructed as
described above, the length that the scanning line 25
of LD1 scans on the photo sensor 21 becomes equal to
25   the length that the scanning line 26 of LD2 scans on
the photo sensor 22.

(Second Embodiment)

Fig. 3 is a structural view showing a structure of a scanning position detecting sensor according to a second embodiment of the present invention. A scanning position detecting sensor 14 is composed of

5   a photo sensor 32 and a photo sensor 33 which are a triangle axisymmetric with respect to an axis substantially perpendicular to the scanning direction of a laser beam and have the same shape and the same size as in the case of the first embodiment. Those

10   photo sensors are arranged at positions at a space of d in a direction substantially perpendicular to a scanning direction X.

The space d is set equal to 600 dpi (42.23 μm). The photo sensor 32 is selected so as to receive only

15   a light output from a spot irradiated with a laser beam 1 (LD1) and the photo sensor 32 is selected so as to receive only a light output from a spot irradiated with a laser beam 2 (LD2). Here, in the case where a scanning space between a scanning line

20   of the laser beam LD1 and a scanning line of the laser beam LD2 is d, when the scanning position detecting sensor is constructed as described above, the length that the scanning line of LD1 scans on the photo sensor 32 becomes equal to the length that the

25   scanning line of LD2 scans on the photo sensor 33.

(Third Embodiment)

Fig. 4 is a structural view showing a structure

of a scanning position detecting sensor according to
a third embodiment of the present invention. A
scanning position detecting sensor 14 is composed of
a photo sensor 35 and a photo sensor 36 which are a
5   pentagon axisymmetric with respect to an axis
parallel to the scanning direction of a laser beam
and have the same shape and the same size. Symmetric
axes of the respective sensors are arranged at
positions at a space of d in a direction
10   substantially perpendicular to a scanning direction X.

      The space d is set equal to 600 dpi (42.23 μm).
The photo sensor 35 is selected so as to receive only
a light output from a spot irradiated with a laser
beam 1 (LD1) and the photo sensor 36 is selected so
15   as to receive only a light output from a spot
irradiated with a laser beam 2 (LD2). Here, in the
case where a scanning space between a scanning line
of the laser beam LD1 and a scanning line of the
laser beam LD2 is d, when the scanning position
20   detecting sensor is constructed as described above,
the length that the scanning line of LD1 scans on the
photo sensor 35 becomes equal to the length that the
scanning line of LD2 scans on the photo sensor 36.

      (Fourth Embodiment)

25   Fig. 5 is a structural view showing a structure
of a scanning position detecting sensor according to
a fourth embodiment of the present invention. A

scanning position detecting sensor 14 is composed of a photo sensor 38 and a photo sensor 39. The photo sensor 38 is formed by dividing a photo sensor 40 with an original shape of a photo sensor axisymmetric

5 with respect to a scanning direction X by a symmetric axis 41 and a symmetric axis 42 thereof. The photo sensor 39 has the same shape and the same size as those of the photo sensor 38 and symmetric axes thereof are arranged at positions at a space of d in

10 a direction substantially perpendicular to a scanning direction.

The space d is set equal to 600 dpi (42.23 μm). The photo sensor 38 is selected so as to receive only a light output from a spot irradiated with a laser

15 beam 1 (LD1) and the photo sensor 39 is selected so as to receive only a light output from a spot irradiated with a laser beam 2 (LD2). Here, in the case where a scanning space between a scanning line of the laser beam LD1 and a scanning line of the

20 laser beam LD2 is d, when the scanning position detecting sensor is constructed as described above, the length that the scanning line of LD1 scans on the photo sensor 38 becomes equal to the length that the scanning line of LD2 scans on the photo sensor 39.

25 (Fifth Embodiment)

The photo sensors described in the first to fourth embodiments are of a congruent shape, that is,

a shape in which the photo sensors in each of the embodiments completely coincide with each other when they are overlapped with each other. Because of the congruent shape, with respect to a shape of

5 respective light receiving portions, the edges thereof in a main scanning direction start side are in parallel to each other and the edges thereof in a main scanning direction end side are in parallel to each other. However, the shape is not limited to a

10 congruent shape as in the case of a set of photo sensors 43 and 44 or a set of photo sensors 45 and 46 as shown in Figs. 6A and 6B, respectively. The set of photo sensors are shifted from each other by the predetermined spaces in a direction substantially

15 perpendicular to a scanning direction X without being overlapped with each other, the edges thereof in a main scanning direction start side are in parallel to each other, the edges thereof in a main scanning direction end side are in parallel to each other, and

20 the edge in the main scanning direction start side and the edge in the main scanning direction end side are not parallel to each other. Here, in the case where the set of the photo sensors are arranged in positions at a space of d and a scanning space of

25 laser beams is d, when the scanning position detecting sensor is constructed as described above, the lengths that the respective scanning lines scan

on the respective photo sensors become equal to one
another.

(Sixth Embodiment)

Fig. 7A, 7B, and 7C each show a scanning
position detecting sensor composed of two photo
sensors having the same shape, that is, a photo
sensor 47 and a photo sensor 48. The photo sensor 47
and the photo sensor 48 are arranged at a space of d
in a direction substantially perpendicular to a
scanning direction X so as not to overlap with the
scanning direction X of two laser beams (LD1 and LD2).
With respect to a shape of the respective photo
sensors, as shown in Fig. 7B, when a length of a
maximum side in a direction parallel to the scanning
direction is given by "a", a length of a minimum side
therein is given by "b", and a length from the side
substantially perpendicular to the scanning direction
to the bottom of the recess is given by "c", the
relationship of c < b < a is obtained. The photo
sensor 47 is selected so as to receive only a light
output from a spot 23 irradiated with a laser beam 25
(LD1) and the photo sensor 48 is selected so as to
receive only a light output from a spot 24 irradiated
with a laser beam 26 (LD2).

When the space d between the photo sensor 47
and the photo sensor 48 is equal to 600 dpi (42.23
μm), a space between the center line of the recess of

the photo sensor 47 and the center line of the recess of the photo sensor 48 is also d. Therefore, when it is controlled such that a scanning line 25 of LD1 passes through the recess portion of the photo sensor

5   47 and a scanning line 26 of LD2 passes through the recess portion of the photo sensor 48, a scanning space becomes 600 dpi.

Further, as shown in Fig. 7C, in the case of a scanning position detecting section 14 composed of

10 three photo sensors, in which a photo sensor 49 is located at a position apart from the photo sensor 47 by 2 × d, when it is controlled such that the laser beam 26 (LD2) is shifted by resolution conversion to pass the beam through the recess portion of the photo

15 sensor 49, a scanning space becomes 300 dpi.

Note that the example of the photo sensor in which the length of the minimum side is given by "b" is described above. However, a photo sensor having a shape of b = 0 may be used. In such a sensor, a

20 relationship of c < a is satisfied. In addition, each of the light receiving portions has a shape in which one edge in a main scanning direction start side is substantially perpendicular to the main scanning direction and a recess is provided to the

25 other edge in a main scanning direction end side. However, a reverse structure may be used. In other words, it is a shape in which one edge in the main

scanning direction end side is substantially
perpendicular to the main scanning direction and the
recess is provided to the other edge in the main
scanning direction start side.

5   (Seventh Embodiment)

Fig. 8 shows another structure of a scanning
position detecting sensor according to the present
invention. A scanning position detecting sensor 14
is composed of a photo sensor 52 and a photo sensor

10   53, which are pentagons. The recess portions are
formed by mask processing using members 51 (hatched
regions) which do not reflect light. Thus, light
traveling to the mask regions is not entered into the
sensors, so that the same effect as that of the

15   embodiment shown in Fig. 7A is obtained.

(Eighth Embodiment)

Fig. 9 shows still another structure of a
scanning position detecting sensor according to the
present invention. A scanning position detecting

20   sensor 14 is composed of a photo sensor 54 and a
photo sensor 55. Each of the photo sensors has two
recesses. Lengths from the side substantially
perpendicular to the scanning direction to the
bottoms of the respective recesses are different from

25   each other. When a length of a maximum side in a
direction parallel to the scanning direction is given
by "a", a length of a minimum side therein is given

by "b", lengths from the side substantially
perpendicular to the scanning direction to the
bottoms of the recesses are given by "c" and "f" (c <
f), the relationship of c < f < b < a is obtained.

5   Further, a space between the center lines of the two
recesses is d (for example, 600 dpi). Therefore,
when it is controlled such that the scanning line of
LD1 passes through the recess f-side portion of the
photo sensor 54 and the scanning line of LD2 passes

10   through the recess f-side portion of the photo sensor
55, a scanning space becomes 600 dpi. Similarly,
when it is controlled such that the scanning line of
LD1 passes through the recess f-side portion of the
photo sensor 54 and the scanning line of LD2 passes

15   through the recess c-side portion of the photo sensor
55, a scanning space becomes 300 dpi. Thus, the
number of photo sensors smaller than that in the
embodiment shown in Fig. 7C allows resolution
conversion.

20   (Structure of Detecting Circuit and Algorithm)
        Fig. 10 is a block diagram showing a structure
of a scanning position detecting circuit 19 of the
present invention. The case where the scanning
position detecting sensor 14 according to the sixth

25   embodiment is used will be described as an example.
A photo sensor output current signal 145 from the
scanning position detecting sensor 14 is converted to

an output voltage signal 147 by a current-voltage transforming circuit 146. An amplifier 148 has an arbitrary gain, amplifies the output voltage signal 147, and inputs an output voltage signal 149 to a

5   sample/hold circuit 150. The sample/hold circuit 150 samples the output voltage signal 149 in accordance with a sample/hold signal 151. The sample/hold signal 151 is a control signal which is generated by an external control circuit (not shown), used for

10   obtaining a sample voltage signal 152 by sampling the output voltage signal 149 during a predetermined period in synchronization with the rise of the photo sensor output current signal 145, and used for holding the sample voltage signal 152 during a period

15   except the predetermined period. In an analog-digital (A/D) transforming circuit 153, when an analog-digital (A/D) conversion control signal 154 is outputted thereto, the sample voltage signal 152 is subjected to digital conversion to obtain an output

20   signal 155 of the analog-digital (A/D) transforming circuit 153.

A photo sensor output current signal 156 from the scanning position detecting sensor 14 is converted to an output voltage signal 158 by a

25   current-voltage transforming circuit 157. An amplifier 159 has the same gain as that of the amplifier 148, amplifies the output voltage signal

158, and inputs an output voltage signal 160 to a
sample/hold circuit 161. The sample/hold circuit 161
samples the output voltage signal 160 in accordance
with a sample/hold signal 162. The sample/hold

5   signal 162 is a control signal which is generated by
an external control circuit (not shown), used for
generating a sample voltage signal 163 using the same
sampling period as in the case of the sample/hold
signal 151 in synchronization with the rise of the

10   photo sensor output current signal 156, and used for
holding the sample voltage signal 163 during a period
except the sampling period. In an analog-digital
(A/D) transforming circuit 164, when an analog-
digital (A/D) conversion control signal 165 is

15   outputted thereto, the sample voltage signal 163 is
subjected to digital conversion to obtain an output
signal 166 of the analog-digital (A/D) transforming
circuit 164.

      The output signal 155 of the analog-digital

20   (A/D) transforming circuit 153 and the output signal
166 of the analog-digital (A/D) transforming circuit
164 are inputted to a comparator 167. When both
signals coincide with each other, a scanning position
consistent signal 168 is outputted.

25   Fig. 11 is a timing chart showing output states
of main blocks. Hereinafter, the case where a phase
position detecting sensor 14 is scanned with two

laser beams will be described as an example. In an
nth scanning line, the output signal 149 of the
amplifier 148 is a signal obtained by amplifying the
photo sensor output current signal 145 outputted at a

5   time when a photo sensor "g" on the phase position
detecting sensor 14 is scanned with LD1. On the
other hand, the output signal 160 of the amplifier
159 is a signal obtained by amplifying the photo
sensor output current signal 156 outputted at a time

10   when a photo sensor "h" on the phase position
detecting sensor 14 is scanned with LD2. Now, when a
space d' between the scanning line of LD1 and the
scanning line of LD2 is equal to the space d between
the photo sensor "g" and the photo sensor "h", a

15   pulse width of the output signal 149 of the amplifier
148 is also equal to that of the output signal 160 of
the amplifier 159. Further, the sample voltage
signal 152 becomes equal to the sample voltage signal
163. A digital value of the output signal 155 of the

20   A/D transforming circuit 153 which is obtained by
conversion according to the A/D conversion control
signal 154 coincides with a digital value of the
output signal 166 of the A/D transforming circuit 164
which is obtained by conversion according to the A/D

25   conversion control signal 165. As a result, the
scanning position consistent signal 168 is outputted.

On the other hand, in an (n+1)th scanning line,

when a space d'' between the scanning line of LD1 and

the scanning line of LD2 is larger than the space d

between the photo sensor "g" and the photo sensor "h",

the pulse width of the output signal 160 of the

5   amplifier 159 becomes narrower than that of the

output signal 149 of the amplifier 148. As a result,

the sample voltage signal 163 becomes smaller than

the sample voltage signal 152. A digital value

(7FA)h of the output signal 166 of the A/D

10   transforming circuit 164 which is obtained by

conversion according to the A/D conversion control

signal 165 becomes smaller than a digital value

(8DE)h of the output signal 155 of the A/D

transforming circuit 153 which is obtained by

15   conversion according to the A/D conversion control

signal 154. Those output signals 155 and 166 are

compared with each other by the comparator 167, and

it is determined that the space d'' between the

scanning line of LD1 and the scanning line of LD2

20   does not coincide with the space d between the photo

sensor "g" and the photo sensor "h". Thus, the

scanning position consistent signal 168 is not

outputted.

      Fig. 12 is a block diagram showing another

25   structure of a scanning position detecting circuit of

the present invention. The case where the scanning

position detecting sensor 14 according to the

embodiment shown in Fig. 7A is used will be described

as an example. An output current signal S250 from

the photo sensor 47 of the scanning position

detecting sensor 14 is converted to an output voltage

5   signal S252 by a current-voltage transforming circuit

250. An amplifier 252 has an arbitrary gain,

amplifies the output voltage signal S252, and inputs

an amplified signal S254 to a selector 255. On the

other hand, an output current signal S251 from the

10   photo sensor 48 is converted to an amplified signal

S256 by similar circuits 251 and 253 and is then

inputted to the selector 255. The selector 255

selects either the amplified signal S254 from the

photo sensor 47 or the amplified signal S256 from the

15   photo sensor 48 according to a mode of a mode signal

S257 from a CPU which is not shown and outputs the

selected signal. This mode indicates an initial

adjustment mode at the time when the scanning

position detecting sensor is mounted or a normal mode

20   after the completion of the initial adjustment. In

other words, with respect to both the photo sensors,

the completely same circuits may be arranged for post

stage circuits such as a time measuring circuit and a

discriminating circuit without providing the selector

25   255. Note that circuits related to the photo sensor

47 which becomes a reference position are used only

in the initial adjustment in which the photo sensor

47 is positioned. Therefore, in the normal mode
after the position of the photo sensor 47 is
determined, the selector 255 is switched in
accordance with the mode signal S257 so that the
amplified signal S256 is inputted to a time measuring
circuit 256 of a post stage. The time measuring
circuit 256 measures a pulse width of the inputted
amplified signal S256 based on a clock S258 and
outputs a measurement result S262 to a discriminating
circuit 257. The discriminating circuit 257 compares
the measurement result S262 with predetermined pulse
widths S259 and S260 and adjusts the scanning line of
LD2.

This operation will be described with reference
to Figs. 13A and 13B. When the measurement result
S262 inputted to the discriminating circuit 257 is
related to scanning (1) shown in Fig. 13A, the
discriminating circuit 257 determines $S262(1) > S260$
and outputs to a CPU which is not shown a control
signal S261 for operating the scanning line of LD2 in
a direction apart from LD1 (down direction in Fig.
13A). Even if the measurement result S262 is related
to scanning (2) at next determination, $S262(2) > S260$
is determined and the scanning line of LD2 is
operated in the direction apart from LD1. When
$S262(3) < S259$ is satisfied, the discriminating
circuit 257 outputs a stop signal S261 to the CPU

which is not shown and ends the adjustment. In
addition, when the measurement result S262 inputted
to the discriminating circuit 257 is related to
scanning (1)' shown in Fig. 13B, the discriminating

5 circuit 257 determines S259 < S262(1)' < S260 and
outputs to the CPU which is not shown a control
signal S261 for operating the scanning line of LD2 in
a direction approaching LD1 (up direction in Fig.
13B). Even if the measurement result S262 is related

10 to scanning (2)' at next determination, S259 <
S262(2)' < S260 is determined and the scanning line
of LD2 is operated in the direction approaching LD1.
When S262(3)' < S259 is satisfied, the discriminating
circuit 257 outputs a stop signal S261 to the CPU

15 which is not shown and ends the adjustment. Those
operations are controlled as in the case where the
position of the scanning line of LD1 is adjusted as
the initial adjustment mode.

Fig. 14 is a flow chart showing a series of

20 those operations. In Fig. 14, when an adjustment
mode is started, first, the CPU which is not shown
determines whether or not the mode is an initial
adjustment mode (F60). When it is the initial
adjustment mode, the amplified signal S254 is

25 selected in order to measure an output signal from
the photo sensor 47 and a time corresponding to a
pulse width thereof is measured (F61). Alternatively,

when it is not the initial adjustment mode but a
normal mode, the amplified signal S256 is selected in
order to measure an output signal from the photo
sensor 48 and a time corresponding to a pulse width

5   thereof is measured (F62). When the measurement
result S262 is equal to or longer than S260 (F63), a
current scanning line is moved downward by a
predetermined amount of movement (F64) and processing
is returned to the adjustment mode (F60). When S262

10   is shorter than S260, processing goes to next
determination (F65). In F65, it is determined
whether or not $S259 \leq S262 < S260$ is satisfied. If
Yes in F65, the current scanning line is moved upward
by a predetermined amount of movement (F66) and

15   processing is returned to the adjustment mode (F60).
If No in F65, processing goes to next determination
(F67). In F67, it is determined whether or not S262
is shorter than S259. If shorter, the adjustment is
ended (F68). Note that, when S262 is 0, laser light

20   is not detected by the photo sensor, so that
processing goes to error processing (F69).

    With respect to the above-mentioned contents,
in the case of the structure of three sensors which
is described in the embodiment as shown in Fig. 7C, a

25   set of circuits may be added in the front of the
selector without modifying the circuits located in
the rear of the selector. In addition, in the case

of the sensor structure having the plurality of
recesses which is described in another embodiment as
shown in Fig. 9, the number of pulse widths used for
comparison in the discriminating circuit has only to
5   be increased. Thus, applications are easily possible.